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AGRICULTURAL LIME ANALYSES

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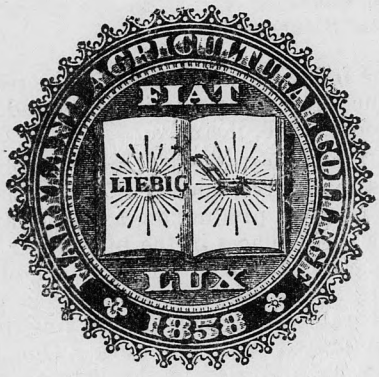

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Chemical Department, Maryland State College of Agriculture

COLLEGE PARK, MD.

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ANALYSES OF

Agricultural Lime Sold in Maryland

BY THE CHEMICAL DEPARTMENT OF

The Maryland State College of Agriculture

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The tables on the following pages contain the results of the analyses of agricultural lime offered for sale in Maryland, and sampled from July, 1915, to October, 1916, inclusive.

Due to the fact that lime will vary considerably, even in the same lot and from the same source, special effort has been made to collect the samples at the point of production, and to draw the samples from a considerable number of places in the pile or car, thoroughly mixing and reducing in size the pieces in the large sample and reducing the samples by halving and quartering down to a convenient size for sending to the laboratory, the samples having been drawn by the official samplers connected with the work. Due to the difficulty of getting proper samples and also to the expense of analyzing them, it has not been possible to accept miscellaneous samples for analysis. The product being somewhat variable, one should not expect as close agreement of samples taken at different times from the same source as we expect in commercial fertilizer, where the product is not only more uniform but where the useful elements are much more valuable per unit and the percentage is much smaller than in the case of commercial lime.

Lime and agricultural lime, strictly speaking, should mean the product resulting from "burning" some form of carbonate of lime, giving a more or less pure oxide of calcium or pure lime. However, as carbonate of lime itself, either as ground limestone, ground oyster

shells, gas lime, etc., are often used to neutralize the acidity of soil, and the slaked or hydrated lime is also used for the same purpose. It is frequently the case that all these forms of calcium used to neutralize acidity of soils are called lime. It is a misnomer, however, to call the ground rock or pulverized oyster shells "lime." They should be given their proper designation so as not to mislead the purchaser.

It is now recognized that some form of lime, using the term in its broad sense, is essential to successful agriculture in most cases. It will not take the place of farm manures or commercial fertilizers, but has a value of its own that cannot be taken by other substances. A discussion of the various ways in which lime acts cannot be taken up here, especially as the farmer is not so much concerned as to the way in which lime acts as he is in the fact that lime is necessary, and the principal questions are: What form to use. How much to apply? and When to apply lime? It may be said that lime especially promotes the growth of clover and other leguminous crops that have the power of taking up nitrogen from the air and adding it to the soil, in this way storing up this valuable element of fertility for the use of other crops, especially the cereals and grasses.

Most soils, except soils containing marl or other forms of carbonate of lime, will be found to be benefitted by liming. This is especially the case where clover does not grow well and where the soil gives the usual tests for acidity.

Other than the above indications, the easiest test to make on the soil is the Litmus Test, which will, in most cases, give a qualitative indication of acidity. Various ways have been suggested for making the test.

Making the Litmus Test.

Litmus is a blue coloring matter or dye but is generally used in the form of litmus paper. This is normally blue and is changed to red by acids. This paper is prepared by dipping unsized paper, like filter paper used by chemists, into a solution of the litmus dye and allowing it to dry. A red litmus paper is also prepared in a similar way from litmus solution that has been changed to red by just enough acid to effect the change. The red paper is changed back to blue by alkalis, such as ammonia, caustic potash, caustic soda, etc. The blue paper only is used in testing soil. It can be purchased from chemical supply houses or drug stores. For soil testing it is conveniently cut into pieces about one-half inch by one inch in size. Samples of soil are taken with a trowel, spoon, small shovel or suitable tool from various places in the field to be tested, avoiding the immediate surface to a depth of say one-half inch or so. The samples may be taken in a large envelope or paper bag on which the number, locality, etc., may be written. For testing, a tablespoonful of the sample should be put into a suitable vessel, as a jelly glass or saucer, and mixed with a small amount of acid-free water, such as distilled water or pure

rain water, and mixed and kneaded with a spoon or knife until the consistency of a thin putty. A cut is made into this with the point of a knife or spoon and a piece of litmus paper inserted and the soil then pressed against the strip of litmus paper which should be allowed to remain at least ten minutes, when it should be carefully removed and the soil washed off by a small stream of pure water or by moving the end of the paper back and forth in pure water contained in a cup or other vessel. If the soil is acid the litmus paper at the point of contact will be turned more or less red, which will be readily recognized by comparing the part of the paper where it had been in contact with the soil with the other end of the same piece of paper. Different tests from different samples can also be compared. A variation of the test having some advantages consists in placing the piece of litmus paper in the bottom of a moist glass beaker, tumbler or jelly glass having a plain bottom. On top of the litmus paper is placed a slightly larger piece of filter paper. The moist soil, as prepared above, is placed on top of this and pressed down and allowed to stand for about half an hour, when the litmus paper may be examined through the glass and the color compared with the color of similar litmus paper without soil and with other samples of soil tested in the same way. The object of this method is to prevent the paper being stained by the soil itself, which may interfere with observing the change in the color of the litmus.

Amount of Lime to Apply.

This depends on the natural acidity of the soil and if lime has been recently applied to the soil, and, as liming is an expensive operation, it is not desirable to apply more than can be done with profit. As a general rule, one ton of good quick lime or burned lime per acre or its equivalent in other forms of lime or limestone will be sufficient for the first application. Use a somewhat smaller quantity about every five years or at each crop rotation.

Forms of Lime.

Lime or quick lime is made by heating some form of carbonate of lime such as limestone, marble, oyster shells, etc., to a high temperature, usually in kilns built especially for the purpose. At a high temperature the carbonate of calcium, frequently called carbonate of lime, chemical formula $CaCO_3$ breaks up into carbonic acid gas or carbon dioxide (CO_2) which passes off into the air, and calcium oxide or lime (CaO). This is used for making mortar, whitewash, etc., and also in agriculture. It has the power of combining chemically with water when treated with water, with steam, or even with moist air, giving the "hydrated lime" or "slaked lime," or in case it occurs in the air the product is called air-slaked or "air-slacked" lime. The slaked lime, when exposed to the air takes up the carbon dioxide

of the air again forming carbonate of lime, similar chemically to the original limestone. As the amount of carbon dioxide in normal air is only three one-hundredths of one per cent the action is necessarily very slow except where the lime is spread out in a very thin layer. It is more rapid when the lime is mixed with the soil, as the air in the pores of the soil contains much more carbon dioxide than does the air above the soil.

Hydrated lime, as it is offered in commerce, is either made by treating the finely crushed or ground quick lime with steam and screening the product, or in many cases, by simply adding water to burned lime and after a time passing the slaked lime through a screen similar to the ordinary sand screen used by plasterers or bricklayers to screen the sand used in making mortar.

Limestone and oyster shells, both being carbonate of lime, are frequently used for agricultural purposes after being more or less finely pulverized. In some cases this fine product is the by-product from a crusher used to prepare crushed limestone for building purposes, road making, etc., or from oyster shells crushed for poultry, pigeons, etc., the dust and finer material being screened out and used for agricultural purposes.

Many limestones also contain magnesium carbonate and when burned give a mixture containing magnesia or magnesium oxide as well as calcium oxide. Magnesium lime does not slake so readily as a high calcium lime. The action of the water is slower and less heat is evolved. The weight of evidence is, however, that magnesium lime, especially where the megnesia does not exceed the amount of lime present, may be regarded as equally good for purposes of agriculture, so that in comparing the analyses of lime the sum of the two oxides should be considered. When lime is added to the soil it, of course, first slakes, if this has not been done previous to the addition, and then, whether quick lime or hydrated lime, very soon changes to carbonate of lime. The question may then be asked: Why use quick or hydrated lime at all? There are several advantages and some disadvantage in using quick lime. Some of the advantages are that the limestone or shells are more cheaply converted to a usable form by burning and hydration than by grinding, and the oxides weighing only slightly more than half of the original weight of the stone or shells contain all of the lime, hence, makes a smaller bulk and weight to handle, and effects a large saving in freight. It has the disadvantage that it should be slaked before spreading and also that it is more disagreeable to handle, due to its strong corrosive properties when coming in contact with the skin of man or animals or when the dust is inhaled.

Carbonate of lime in the form of ground limestone or oyster shells may often be obtained cheaply as a by-product and is also frequently made by simply grinding in mills so that the entire product is ground fine enough for agricultural purposes. Different authorities are not entirely agreed as to the proper fineness that should be used. All are agreed, however, that the finer the material, the more rapid is

its action in the soil and the more rapidly it will dissolve. We think it desirable that 70 to 75 per cent of the material should pass through a 100-mesh screen or sieve. This means a screen, usually made of brass wire, in which the wires are placed 100 to the inch in each direction. In such a screen the opening between the wires are about one two-hundredth of an inch square. Some authorities claim that material passing a 60-mesh screen is fine enough, especially as it does not cost as much to grind to a fineness of 60-mesh as it does to grind to a fineness of 100-mesh. In any case, the coarser the material the more should be applied and the longer the application will last. Material coarser than 20-mesh has but little value.

The Removal of Lime.

If lime is not applied in the form of carbonate of lime it is soon changed to the carbonate in the soil, as above stated. Hence, the removal of the lime from the soil resolves itself to the question, What becomes of the calcium carbonate in the soil? Calcium carbonate is nearly insoluble in pure water, but as air contains some carbonic acid gas and the air or gases in the soil contain considerable carbonic acid gas and as this gas dissolves in ordinary water, as rain water, making a weak acid in which calcium carbonate dissolves slowly, most of the carbonate of lime is thus removed in the drainage water. This is what gives us the ordinary "hard" water, commonly caused by carbonate of lime being dissolved in the water, due to the carbonic acid present. However, other substances as calcium surfate or land plaster and magnesium compounds will also make "hard water." A comparatively small amount of the lime is taken up by plants, as a rule. A good crop removes approximately the amount of pure lime (Calcium Oxide) per acre indicated below:

Alfalfa	200 lbs.
Cabbage, clover and tobacco	100 lbs.
Potatoes	30 lbs.
Corn	15 lbs.
Wheat	10 lbs.

Kind of Lime to Use.

The kind of lime to use will depend to a considerable extent on the locality, nearness of various sources, freight rates, hauling, etc. As lime is used primarily to neutralize acidity, it should be remembered that this power depends upon the amount of calcium and magnesium oxides present, whether in the form of the oxide proper, the hydrate or the carbonate. A perfectly pure lime or quick lime should contain, of course, 100 per cent of calcium oxide. However, this purity is never obtained commercially, and even a first-class lime will very rarely contain over 90 per cent of the oxide, due to

slight impurity in the stone, and small amounts of carbon dioxide, water, etc., necessarily present. A good ground stone or shells should contain about 50 per cent of the oxide. This form is somewhat slower in its action than the quick lime, due to the fact that the latter is more finely divided in the soil. Two tons of ground stone are required to replace one ton of the quick lime. If two tons of the finely ground stone can be applied to the ground at a cost not exceeding one ton of the quick lime, it can then be used on equal footing. This will, of course, depend on the original price, the freight rate and the cost of hauling. If each must be shipped a hundred miles or so, the comparative prices, delivered at the farmer's railroad station, not counting the hauling, would be about as follows:

One-ton lump lime	$4.00
Freight, per ton	2.00
Cost to farmer, per acre	6.00

GROUND LIMESTONE OR SHELLS.

Two tons, at $2.00 per ton	$4.00
Freight, at $2.00 per ton	4.00
Cost to farmer, per acre	8.00

If the farmer has a short haul it may be that for the greater convenience in handling he would prefer to pay the extra amount for the ground stone or shells.

There are several by-products on the market that can be used for lime for agricultural purposes. One is gas lime which contains usually about 35 per cent of calcium oxide, and three tons of this should be used per acre where one ton of quick lime would do the work. This would probably cost about $1.00 per ton loaded on cars. Three tons would cost $3.00; freight on three tons, at $2.00 per ton, $6.00, or a total of $9.00 for material for one acre on basis mentioned above. Gas lime is not now made, but thousands of tons are available from the old process of gas purification used some years ago. A somewhat similar grade of lime is now made as a by-product in certain paper mills. The price, of course, should be low and the haul short in order that such material can compete with quick lime.

APPLYING LIME.

Lime should never be plowed under, but should be applied to the top of plowed ground and well harrowed in. A good time to apply is when turning down sod for corn. It can also be applied before seeding to wheat and grass.

Finely ground quick lime is furnished for agricultural purposes, usually in bags, at a cost of from $6.00 to $6.50 per ton. It is a convenient form in which to have the lime, as it may be distributed

from a fertilizer attachment to a drill, or a lime spreader with no preliminary treatment, but its high cost, will in most cases, prohibit its use. It is frequently the case also, that the quality is poor, due to inferior lime that cannot be marketed in other forms being used in its manufacture.

Hydrated line, when of a high grade, contains about 70 per cent of actual lime and is a convenient and efficient form of lime to use, the principal objection to it being the high cost.

Plaster or *land plaster,* which is calcium sulfate, is not much used at the present time. It has no value for neutralizing acid in soil, and if it does produce a good effect, it is due to action in other ways. It should be remembered that ordinary acid phosphate is more than half plaster, formed as a by-product in the manufacture of the acid phosphate and not added as an adulterant.

Comparative Values of Different Forms of Lime.

The power of lime to neutralize acidity in soil depends of the amount of actual lime, CaO, present. (Magnesia, MgO, while slightly more efficient in correcting acidity, is not so desirable in some respects and may be given the same value as the same amount of lime.) The comparative values of different forms of lime may be tabulated as follows:

Contains or is equivalent to	100 lbs. Pure Lime, CaO	100 lbs. Pure Slaked Lime $Ca(OH)_2$	100 lbs. Pure Calcium Carbonate.
Pure lime, CaO	100	75.7	56
Pure hydrated lime, $Ca(OH)_2$	132	100	74
Pure calcium carbonate, $CaCO_3$	173	132	100

In practice, however, these sources of lime will be more or less impure and burnt may not contain over 90 pounds to the hundred pounds of pure lime, hydrated lime will seldom exceed 70 pounds of actual lime to the hundred pounds and calcium carbonate from stone or shells will not much exceed 50 pounds of actual lime to the 100 pounds. The actual percentages, or pounds in 100 pounds are given in the tables on the following pages for these materials as actually found by analysis.

Weight of Lime

The weight of a bushel of quick lime will vary greatly, depending upon the material from which it is made, when made from shells, being lighter than that made from stone. The weight of a measured bushel may vary from 60 to 90 pounds. When lime slakes there is a great difference in the bulk from a given volume of quick lime. A good grade of lime with little or no magnesia will slake quickly,

giving off a great deal of heat, and the slaked or hydrated lime formed may occupy three times the volume of the original lime. While lime high in magnesia slakes more slowly, it gives off less heat and the slaked lime formed is less bulky. Hence, lime should not be sold by measure, but by weight, which in fact is the usual way.

Slaking Lime.

There are two ways of slaking lime that has been purchased in a lump form. A method widely used is to mark out the field in rows 30 feet apart each way and place a small pile of lime at each intersection. This will give about fifty small piles to the acre, and if one ton per acre is to be applied the piles should be one-half bushel or 40 pounds each. The piles are then allowed to air-slake and scattered by means of a shovel. Care should be taken that a part of the lime does not get too wet, forming a compact mortar, which cannot be properly distributed, but will dry up into compact lumps. Such lumps are of little value and if this occurs much of the lime may be wasted.

Another method is to slake the lime in a large pile of piles. One or more holes should be left in the top of the pile and water poured therein. It is a good practice to cover the outside of the pile,, except near the top, with turf and dirt, so as to retain the steam formed, as in this case the slaking is more complete. A ton of pure lime should require, theoretically, just about one-third of its weight of water for slaking. In practice slightly more water will be required, due to the fact that some is driven off as steam and due to the further fact that the hydrated lime will take up some water as such without combining chemically with it and still not be wet, so that it will require from 80 to 100 gallons of water to slake a ton of good lime, the amount of water depending on the quality of the lime. After the pile has stood for several days the slaked lime should be screened. The coarse, unslaked lumps, if in an appreciable amount, should be placed in a pile and some water added. It will probably be found that some of them at least will slake and can be used. The fine lime can, of course, be best spread with a lime spreader, but it is possible to spread it with a manure spreader, or it may be spread in the old-fashioned way, with a shovel.

No.	Name of Manufacturer or Agent.	Name of Lime	Place of Sampling.	Calcium Oxide CaO		Magnesium Oxide MgO		Sand & Insoluble (of no value)	
				FOUND.	Guaranteed.	FOUND.	Guaranteed.	FOUND.	Guaranteed.
375	J. E. Baker Co., York, Pa.	*Victor Gr. Lime Stone.	Goldsboro.....	47.05		8.10		2.44	
472	" " " " " "	*Victor Gr. Lime Stone.	Greensboro....	49.15	47.00	5.63	4.00	3.15	
378	" " " " " "	Victor Lump Lime.....	Parsonsburg ..	50.45	47.00	33.53	30.00	2.26	
398	Baltimore Pulverizing Co., Baltimore, Md.	*Gd. Oyster Shell Lime.	Greensboro....	49.55		.25		9.74	
344	S. W. Barrick & Sons,	Agr'l. Lump Lime.....	Woodsboro....	89.30		4.63		2.90	
440	" " [Woodsboro Md.	Agr'l. Lump Lime....	Woodsboro....	77 30		13.90		4.01	
345	" " " "	Fresh Ground Lime....	Woodsboro....	72.50		5 79		7.60	
441	" " " "	Ground Lime.....	Woodsboro....	70.60		5.23		11.02	
346	" " " "	Hydrated Lime.....	Woodsboro..	64.10		3 95		7.20	
442	" " " "	Hydrated Lime.....	Woodsboro....	63 60	56.00	2.86		8.90	
416	Baugh & Sons Co., Baltimore, Md.	Land Plaster.....	Baltimore.....	†22.75		.82		4.32	
454	B. Frank Beard, Wrightsville, Pa.	Agr'l. Lime.....	Wright'lle, Pa.	57.50	70.00	37.24		1.93	
399	Beaver Dam Marble Co., Cockeysville, Md.	*Agr'l Gd. Lime Stone	Cockeysville...	30.05	29.90	19.44	22.33	3 60	
376	F. & H. Benning Galloways, Md.	Oyster Shell Lime Hyd.	Galloways.....	57.40		.41		6.22	
407	J. R. Bittinger, Hanover, Pa.	Agr'l Lump Lime.....	Hampstead....	93.02		3.29		2.83	
443	Blair Limestone Co. Pitts-	Gr. Lime Screenings ...	Martinsburg, W. Va.	77.20	80.00	1 03		10.65	
444	" " " (burgh, Pa.	Opequon Hydrated Lime	Martinsburg, W. Va.	73.35	65.00	2.34		10.13	
401	Wm. Brown, Woodsboro, Md.	Lump Lime.....	Walkersville ..	83.05		8.84		1 22	
474	H. Bryant's Son, Alexandria, Va.	*Ground Oyster Shells..	Wash. Grove..	46.50		.83		11.85	
371	G. M. Bushey & Son, Cave-	Agr'l Lump Lime	Cavetown	71.30		22.37		1.10	
445	" " " [town, Md.	Agr'l Lump Lime.....	Cavetown	75.05		13.26		5.60	

387	Carbo Agricultural Lime Co. Wilmington, Del	Carbo, Lime.....	Pocomoke City	35.06	27.80	1.10	1.50	5.14
385	Chesapeake Oyster Shell Co., Crisfield, Md.	*Ground Oyster Shells..	Crisfield.....	50.75				4.78
411	Consolidated G. E. L. & P. Co., Baltimore, Md.	Gas Lime	Baltimore.....	48.65		.27		5.96
455	G. & W. H. Corson, Plymouth	Prepared Hydrated Lime	Plymouth Mtg. Pa...	44.40	42.00	26.25		3.38
456	" " [Meeting, Pa.	Run of Kiln Lime	Plymouth Mtg. Pa...	58.01		38.83		.70
402	David A. Devilbiss, Walkersville, Md.	Lump Lime	Walkersville ..	86.20		4.41		1.10
408	Anthony J Dressman, Cumberland, Md.	Lump Lime	Cumberland...	71.70		2.09		4.95
457	Emig Lime Co., Hellam, Pa.	Run of Kiln Lime	Hellam Pa....	88.02	70.00	2.28		4.57
379	D. Feeney, Texas, Md.	Agr'l Lime.....	Texas.....	87.10		2.38		9.60
347	Fountain Rock Lime Co.,	Agr'l Lump Lime	Fountain Rock	88 00		2 15		5.01
417	" "[Woodsboro, Md.	Agr'l Lump Lime	Fountain Rock	88 90		1.54		7.03
348	" " " "	Fresh Ground Lime ...	Fountain Rock	66.85		10 48		7 02
418	" " " "	Ground Lime.....	Fountain Rock	64.30		3.44		11.46
349	" " " "	Hydrated Lime.....	Fountain Rock	53.10		12.26		8 04
419	" " " "	Hydrated Lime	Fountain Rock	60.55		5 03		12.16
386	Gilmore Bros., Loch Raven, Md.	*Lime Stone.....	Towson.....	30.60	52.00	20.63	43.00	1.80
382	Robt. S. Green, Balto., Md.	Oyster Shell Lime.....	Frederick Road	73.60		.94		10.78
420	M. J. Grove Lime Co.,	Agr'l Lump Lime	Groves.....	85.35		8.87		4.60
350	" " [Frederick, Md.	Agr'l Lump Lime	Groves.....	93.60		4.85		1.09
351	" " " "	Agr'l Lump Lime	Lime Kiln....	78.90		3.98		5.57
421	" " " "	Fresh Ground Lime.....	Groves.....	64.25		13.63		16.28
422	" " " "	Hydrated Lime.....	Groves.....	56.40	65.00	4.76		9.40
353	" " " "	Hydrated Lime.....	Groves.....	60.75		4.07		10 30
403	Chas. S. Houck, Frederick, Md.	Agr'l Lump Lime.....	Frederick.....	81.30		1.26		4.60
409	J. S. Hyde, Westminster, Md.	Agricultural Lump Lime	Westminster ..	88.60		13 08		2.68
446	" " " "	Agricultural Lump Lime	Westminster	89.60		1.50		4.01
436	Wm. Hyde, Union Bridge, Md.	Agricutural Lump Lime	Union Bridge..	96.25		1.35		.84

† Pure Plaster (Hydrated Calcium Sulfate.) 65.40%

*Ground Shells or Stone.

Mechanical Analysis on page 15.

No.	Name of Manufacturer or Agent.	Name of Lime	Place of Sampling.	Calcium Oxide CaO		Magnesium Oxide MgO		Sand & Insoluble (of no value)	
				Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.
354	A. M. Isanogle, Thurmont, Md.	Agricultural Lump Lime	Thurmont.....	63.30		30.01		1.10	
423	" " " "	Agricultural Lump Lime	Thurmont.....	56.35		36.62		3.45	
355	O. J. Keller Lime Co.,	Agricultural Lump Lime	Buckeystown..	85.20		5.14		6.35	
424	" " [Buckeystown, Md.	Agricultural Lump Lime	Buckeystown..	93.60		1.43		2.31	
356	D. C. Kemp Lime Co.,	Agricultural Lump Lime	Frederick	72.50		15.67		8.00	
425	" " "Frederick, Md.	Agricultural Lump Lime	Frederick	74.25		9.10		12.10	
426	" " " " "	Hydrated Lime.....	Frederick	51.35		14.40		11.60	
393	Peter Kessler & Sons, Butler, Md.	*Ground Lime Stone	Cockeysville...	47.15		6.80		7.48	
410	H. J. Kneriem, Cresaptown, Md.	Lump Lime	Cresaptown....	86.85		2.09		2.33	
458	Knickerbocker Co., Phila, Pa.	Ground Fresh Lime.....	Malvern, Pa...	56.50	50.00	35.35		3.01	
460	" " "	Hydrated Lime	Malvern, Pa...	48.65	50.00	30.83		3.30	
461	" " "	Run of Kiln Lime	Malvern, Pa...	59.50		38.42		.80	
357	Legore Combination Lime Co.,	Agr'l Lump Lime	Legore.....	82.00		4.22		4.70	
427	" " [Legore, Md.	Agr'l Lump Lime	Legore.....	90.10		2.57		4.52	
439	" " " "	*Ground Lime Stone....	Snow Hill.....	54.95		2.40		.50	
428	" " " "	Hydrated Lime.....	Legore.....	55.60		2.02		15.05	
358	" " " "	Hydrated Lime.....	Legore.....	61.55		4.70		5.51	
381	W. P. Lindsay, Texas, Md.	Agr'l Lime.....	Texas.....	90.00		8.23		.79	
473	" " " "	Lump Lime.....	Texas.....	83.55		.90		8.25	
462	Merion Lime & Stone Co.,	Agr'l Lump Lime	Norristown, Pa.	59.35	80.00	38.87		.40	
463	" " [Norristown. Pa.	Ground Fresh Lime.....	Norristown, Pa.	53.25	50.00	34.05		6.98	
464	" " " "	Hydrated Lime.....	Norristown, Pa.	47.70	45.00	31.05		4.09	
397	" " " "	Hydrated Lime.....	Church Hill....	48.02	45.00	30.08		2.53	

389	Moore-Pendleton Co., West-	*Pulv'd Oyst'r Sh'l Lime	Westover	51.35	50.00	58		4.74	

389	Moore-Pendleton Co., Westover, Md.	*Pulv'd Oyst'r Sh'l Lime	Westover	51.35	50.00	.58		4.74
373	Oakland Lime & Stone Co., Oakland, Md.	Agr'l Lump Lime.....	Oakland.....	60.10		1.66		20.00
384	G. Ober & Sons Co., Balti-	Nova Scotia Land Pl's'r	Baltimore.....	†32.50	30.00	.63		1.38
438	" " [more, Md.	Nova Scotia Land Pl's'r	Baltimore.....	‡33.50	25.55	1.95		1.00
447	Orem & Winterbottom, Cambridge, Md.	Burnt Oyster Shell Lime	Cambridge	75.35		1.05		6.31
465	Lowell M. Palmer, York, Pa.	Challenge Hyd. Lime...	York, Pa.....	71.50	70.00	4.16		1.05
374	" " "	Challenge Hyd. Lime...	Aberdeen	61.45	70.00	1.66		.54
388	" " "	Challenge Hyd. Lime...	Bel Air.....	73.50	70.00	2.63	3.00	1.05
466	" " "	*Pulv'ed Lime Stone...	York, Pa.....	52.25	48.50	4.28		.56
435	Peerless Oyster Co., Balto., Md.	*Ground Oyster Shells.	Baltimore.....	51.30		.85		4.89
377	" " " " "	*No. 5 Gr. Oyster Shells	Baltimore.....	50 00	53.14	.75		7.94
390	" " " " "	*Crushed Oyster Shells..	Denton.....	49.75		.60		7.06
413	Powhatan Lime Co., Strasburg Junction, Va.	Hydrated Lime.....	Laurel	72.40	50.00	5.75		2.56
380	M. B. Price, Cockeysville, Md.	Agricultural Lime.....	Cockeysville...	72.65		14.49		7.94
359	D. F. Roddy, Emmitsburg, Md.	Agricultural Lump Lime	Emmitsburg...	65.10		26.29		1.30
429	" " " " "	Agricultural Lump Lime	Emmitsburg...	57.05		22.97		5.67
391	Salisbury Lime Co., Salisbury	Hydrated Oy. Shell Lime	Princess Anne.	59.90	70.00	.40		6.40
477	" Md.	Hydrated Shell Lime...	Salisbury.....	61.40		1.23		6.40
478	" " " "	Oyster Shell Lime.....	Princess Anne.	57.02	70.00	1.63		9.65
448	Security Cement & Lime Co.,	Agricultural Lump Lime	Martinsburg, W. Va.	92 72		3.08		1.20
340	Hagerstown, Md. " "	*Ground Lime Stone...	Annapolis	53.30	44.00	.36		3.70
449	" " " "	Ground Lime.....	Martinsburg, W. Va.	85.75	90.00	2.78		1.90
383	" " " "	Hydrated Lime.....	Hyattsville....	69.90	70.00	1.66	2.00	.47
450	" " " "	Hydrated Lime.....	Martinsburg, W. Va.	69.75	70.00	1 86		.67
451	" " " "	*Pulverized L Stone....	Martinsburg, W. Va.	48.65	44.00	4.53		5.15
360	Shank & Etzler, Frederick..	Agricultural Lump Lime	Frederick.....	69.85		26.25		1.85
430	" " " " [Md.	Agricultural Lump Lime	Frederick.....	85.95		13.85		
361	" " " " "	Hydrated Lime.....	Frederick.....	51 80	40 00	25.88		.89 4.00
431	" " " " "	Hydrated Lime.....	Frederick.....	48.40	40.00	23.44		2 15 4.00
369	Somerset Packing Co., Upper Fairmount, Md. " "	Oyster Shell Lime, Hy't'd	Upper Fairm't	44 13		.40		3.30
475		Oyster Shell Lime.....	Upper Fairm't	48.75		.90		3.75
404	Chas. E. Staley, Fred'k, Md.	Agricultural Lump Lime	Frederick	91.65		1.26		1 33
432	" " " " "	Agricultural Lump Lime	Frederick.....	90.90		2.08		1.78
362	Standard Lime & Stone Co.,	Agricultural Lump Lime	Buckeystown..	93 55		5.17		.20
363	Buckeystown, Md. " "	Agricultural Lump Lime	Monrovia.....	95 60		2.31		1.02
433	" " " "	Agricultural Lump Lime	Buckeystown..	94.70		2.22		.55
364	" " " "	Ground Lime.....	Monrovia.....	88.00		4.20		3.24
365	" " " "	Hydrated Lime.....	Monrovia.....	71.40	70.00	3.89		1.57

† Pure Plaster (Hydrated Calcium Sulfate.) 94.45%
‡ Pure Plaster (Hydrated Calcium Sulfate.) 93.85%

No.	Name of Manufacturer or Agent.	Name of Lime	Place of Sampling	Calcium Oxide CaO		Magnesium Oxide MgO		Sand & Insoluble (of no value)	
				FOUND.	Guaranteed.	FOUND.	Guaranteed.	FOUND.	Guaranteed.
332	Geo. R. Staub & Son, Linwood,	Agricultural Lump Lime	Westminster..	85.25		7.48		3.57	
405	" " " " " " [Md.	Agricultural Lump Lime	Finksburg.....	83.20		10 13		1.88	
437	Jas. C. Staub, Westminster, Md.	Agricultural Lump Lime	Wakefield.....	89.10		4.90		3.47	
434	Tabler Lime & Stone Co.,	Agricultural Lump Lime	Frederick.....	85 10		3.96		5.70	
367	Frederick, Md. " "	Fresh Ground Lime.. .	Frederick.....	66.10		2.17		13 47	
392	Thomasville Stone & Lime Co., Thomasville, Pa.	*Ground Lime Stone....	Baltimore	53 60		2.38		.68	
406	Tidewater Portland Cement Co.	Agricultural Lump Lime	Union Bridge..	94.50	92.00	1.13	1.00	.94	
370	" [Union Bridge, Md.	Hydrated Lime.....	Glenelg.....	70.50		1.12		1.80	
452	" " " "	Hydrated Lime.....	Chewsville	73.02	71.50	.83		1.45	
394	W. H. Valliant & Bro., Belle-	* ground Oyster Shells..	Bellevue	49.80		.50		10.13	
476	" " " " " [vue Md.	*Ground Oyster Shells..	Bellevue	48.90		.63		8.70	
467	Chas. Warner Co., Wilmington,	Cedar Hollow Hy. Lime	Devault, Pa...	47.85	41.00	40.02		3.20	
395	" " " [Del.	Limoid.....	Centreville....	49.10	42.00	32.42	28.00	1.02	
453	" " " "	Limoid.....	Price.....	46 10	42.00	32.14	28.00	1.19	
468	" " " "	Pulverized Burnt Lime..	Devault, Pa..	56.30	55.00	37 57		3.35	
396	" " " "	Pulverized Burnt Lime..	Kennedyville..	57.80	56 00	37.43	37.00	2 73	
469	" " " "	*Pulverized Lime Stone	Devault, Pa...	30.50	29.00	20.73		3.47	
470	" " " "	Run of Kiln Lime.....	Devault, Pa...	54.60	53 00	36.97		3.86	
372	Geo. W. Woolford Co., Cambridge, Md.	Hydrated Oyster Shell Lime....	Cambridge	64.30		.57		5.74	
471	York Valley Lime Co., York, Pa.	Chemical Lime.....	York, Pa.....	90.90	80.00	5.74		1.05	

TABLE II—SHOWING MECHANICAL ANALYSIS OF GROUND LIME STONE AND GROUND OYSTER SHELL

TABLE II—SHOWING MECHANICAL ANALYSIS OF GROUND LIME STONE AND GROUND OYSTER SHELL

For the Chemical Analysis of these samples see preceding table

Figures are percentages or pounds per hundred

No.	Name of Manufacturer or Agent	Name of Lime or Kind	Finer than 100 mesh	Bet. and 100 mesh	Bet. 60 and 80 mesh	Bet. 40 and 60 mesh	Bet. 20 and 40 mesh	Coarser than 20 mesh
375	J. E. Baker Co., York, Pa.	Victor Ground Lime Stone.	59	5	5	7	14	10
472	" " " " " "	Victor Ground Lime Stone.	55	5	5	10	15	10
398	Balto. Pulverizing Co., Balto., Md.	Ground Oyster Shell Lime	28	10	11	21	30	
399	Beaver Dam Marble Co. Cockeysville, Md.	Agr'l Ground Limestone....	6	4	3	10	20	57
474	H. Bryant's Son, Alexandria, Va.	Ground Oyster Shells.....	25	9	8	16	29	13
385	Chesapeake Oyster Shell Co., Crisfield, Md.	Ground Oyster Shells.....	44	8	9	13	15	11
386	Gilmore Bros., Lock Raven, Md..	Limestone.....	1	1	2	3	6	87
393	Peter Kessler & Sons, Butler, Md.	Ground Lime Stone.....	15	6	5	15	29	30
439	Legore Combination Lime Co., Legore, Md.	Ground Lime Stone.....	80	4	3	5	6	2
368	Moore-Pendleton Co., Westover, Md.	Pulv'ed Oyster Shells.....	25	6	6	10	22	31
466	L. M. Palmer, York, Pa.	Pulv'ed Lime Stone	70	10	3	6	6	5
435	Peerless Oyster Co., Baltimore,	Ground Oyster Shells.....	12	6	5	21	45	11
377	Md. " " " "	No. 5 Ground Oyster Shells	28	9	7	19	28	9
390	" " " " "	Crushed Oyster Shells.....	40	10	8	18	17	7
340	Security Cement & Lime Co., Hagerstown, Md.	Ground Lime Stone.....	70	5	11	6	8	

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